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FOUR-LOBED SPORE MOTHER CELLS IN CATHARINEA

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In examining some preparations of sporophytes of *Catharinea*, made from fixed material, it was noticed that the spore mother cells were plainly four-lobed. The preparations were laid aside until living material could be studied. This was done during the past summer, with a resulting confirmation of the former observations. Spore mother cells having the four-lobed form have now been found in developing sporophytes collected and fixed in September, 1907, in the neighborhood of Madison; and in living sporophytes collected during August, 1915, at three different localities in and near Madison, and at one locality near Devil's Lake, about thirty miles distant from Madison.

As appears from figure 1, *A-D*, there are rather striking differences in size between the spore mother cells of plants collected in different localities, although the mother cells borne in a single capsule differ little in size, and, so far as my observations have gone, there is no great variation in this respect as between different plants growing in the same clump. Along with these differences in size of spore mother cells between plants of different localities go other well-marked differences in such characters as size of plant, size of leaf, number of lamellae on the upper surfaces of the leaves, and number of spines on the lower surfaces. While doubtless some of these characters are influenced by external conditions, it seems not unlikely that the plants in question may represent distinct races, all of which, however, seem to fall within the limits of *C. angustata* Brid., as at present defined; although, since this species intergrades with *C. undulata* Web. and Mohr, it is possible that some of the forms observed should be referred to the latter species.

The spore mother cells shown in figure 1 were drawn (with the aid of the camera lucida) immediately after being pressed out of the living capsules. The lobing of the cells, though evident, is much shallower than in such representatives of the *Jungermanniales* as

Pellia¹ or Symphyogyna.² An occasional cell (as in figure 2, C) might be described as tetrahedral rather than lobed; the one shown in figure 2, C, however, could be seen in other optical sections than the one drawn to be really somewhat more distinctly

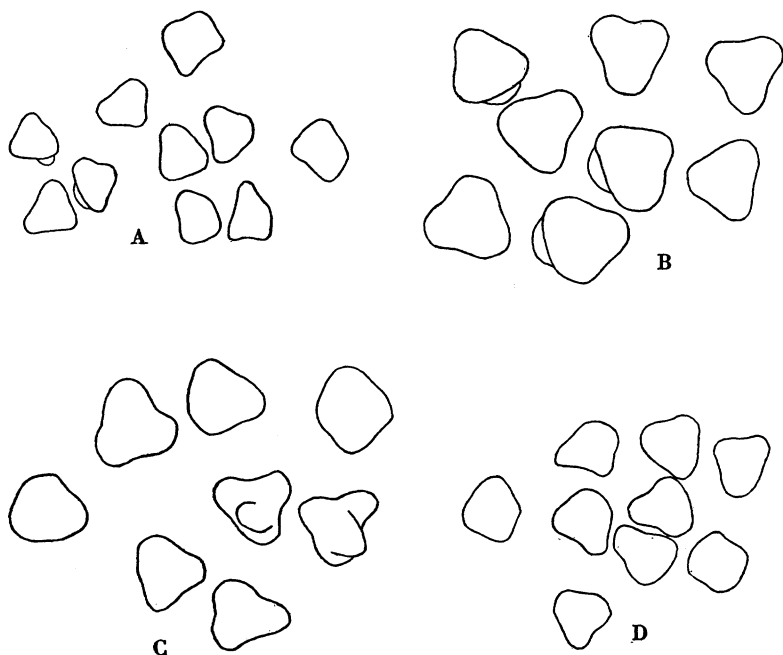


FIG. 1. Groups of spore mother cells from four capsules of *Catharina angustata* From living material.

lobed than this figure would suggest. The shapes of these cells in Catharina are not dissimilar to those of the spore mother cells of Fossombronia.³ Indeed, among the Jungermanniales, in which (if the Sphaerocarpaceae and Riellaceae be excluded) the lobing of the spore mother cells seems to be a universal character, the depth of the

¹ Farmer, J. B. On spore-formation and nuclear division in Hepaticae. *Annals of Botany* 9: 469-523. 1895.

² McCormick, Florence A. A study of *Symphyogyna aspera*. *Bot. Gaz.* 58: 401-418. 1914.

³ Farmer, J. B. *Loc. cit.*

Humphrey, H. B. The development of *Fossombronia longiseta* Aust. *Annals of Botany* 20: 83-108. 1906.

lobing varies greatly. This is shown, for example, by the differences in this respect between two species so closely related as *Blythia* (*Pallavicinia*) *decipiens*⁴ and *B. Lyellii*.⁵

Figure 2 shows stages in the division of the spore mother cell, as seen in sections of fixed material. At the earliest stage here shown

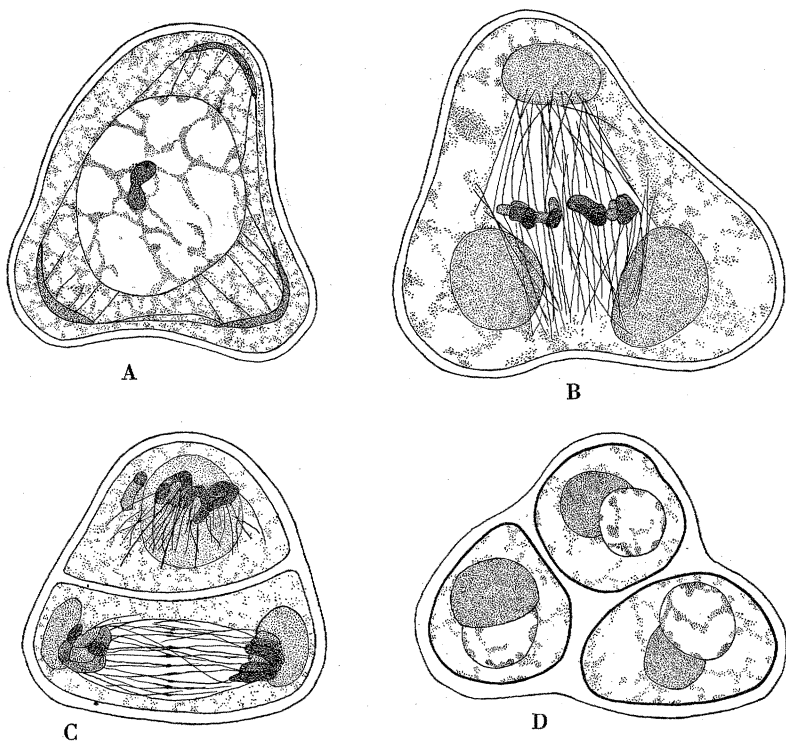


FIG. 2. Stages in the division of the spore mother cell and spore formation in *Catharinea angustata*. From fixed material.

(figure 2, A), the cell contains four plastids which are located respectively in the four lobes of the cell. At this time the plastids seem to have the form of curved plates; later they become more rounded but by no means spherical; the apparent differences in size and shape

⁴ Farmer, J. B. Studies in Hepaticae: On *Pallavicinia decipiens* Mitten. *Annals of Botany* 8: 35-52. 1894.

⁵ Moore, A. C. Sporogenesis in *Pallavicinia*. *Bot. Gaz.* 40: 81-95. 1905.

between the different plastids shown in figure 2, *B-D*, are at least in part due to the fact that these somewhat flattened bodies are seen from different angles.

The fibers that appear in figure 2, *A*, running from each plastid toward the nucleus, seem to be the beginnings of a spindle which in its origin is quadripolar. The mature spindle is bipolar (figure 2, *B*). Each blunt pole lies between two plastids; the upper pole of the spindle shown in figure 2, *B*, is not directed toward a plastid, as the figure might suggest, but lies at a higher focus and between this plastid and another one, not present in the section from which the figure was drawn. Both the first (heterotypic) and the second (homoeotypic) nuclear divisions are followed by the formation of cell plates and of partition walls. Figure 2, *C*, shows the wall that divides the spore mother cell after the first nuclear division, as well as the beginning of the formation of a cell plate on one of the second division spindles. As this figure also shows, the spindles of the second division are so oriented that each spindle pole is directed toward, and in contact with, one of the four plastids. Consequently, each of the daughter nuclei resulting from this division lies in contact with a plastid (figure 2, *D*). The formation of partition walls after the second mitosis completes the division of the spore mother cell into four spores, each of which contains a nucleus and a plastid and corresponds substantially (except for the nucleus) to one of the lobes of the mother cell.

After cell division has been completed, the original wall of the mother cell and the partition walls separating the spores gradually soften. The spores round up somewhat, and each forms an independent wall, at first quite thin, about itself and inside the softening substance of the older walls (figure 2, *D*). Finally the dissolution of the old walls reaches the stage at which the spores become free.

This is, I think, the first observed case of the occurrence of four-lobed spore mother cells in a bryophyte not a member of the Jungermanniales. It remains to be seen to what extent this character appears among the Bryales. Such studies of sporogenesis as have been made in members of the latter order seem to indicate that in general the mother cells are not lobed. The taking on of a lobed form is of interest because it anticipates the division of the cell at a time when there is no evidence either of a preparation for division on the part of the nucleus or of the development of the spindle mechanism. Another anticipatory step is seen in the early division of a single plastid into

four, a process which, known for some time⁶ to occur in *Anthoceros*, is also, to judge from the work of Sapěhin⁷ and Melin,⁸ of common occurrence among the Musci.

⁶ Davis, B. M. The spore-mother-cell of *Anthoceros*. *Bot. Gaz.* 28: 89-109. 1899.

⁷ Sapěhin, A. A. Über das Verhalten der Plastiden im sporogenen Gewebe. *Bericht. Deutsch. Bot. Ges.* 29: 491-496. 1911.

⁸ Melin, E. Die Sporogenese von *Sphagnum squarrosum* Pers. Nebst einigen Bemerkungen über das Antheridium von *Sphagnum acutifolium* Ehrh. *Svensk Bot. Tidsk.* 9: 261-293. 1915.